International Journal of Agricultural Science and Research (IJASR)
ISSN(P): 2250–0057; ISSN(E): 2321–0087
Vol. 9, Issue 6, Dec 2019, 93–100

TRANS STELLAR
•Journal Publications •Research Consultancy

COMPARATIVE ANALYSIS OF THE QUALITY PARAMETER VARIATION OF GRATED COCONUT: FRESH GRATED COCONUT UNDER FROZEN STORAGE COMPARED WITH FREEZE DRIED GRATED COCONUT

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ABSTRACT

Low temperature processed coconut products has a potential market as a supplement for the non-communicable diseases, hence the storage quality parameters of fresh and freeze dried grated coconut samples packed in polypropylene and metalized polypropylene stored under different temperatures were tested for physiochemical quality parameters, microbial parameters and consumer acceptability. Freeze dried grated coconut stored under room temperature caused significantly lower moisture, free fatty acid, peroxide value and water activity increments compared with fresh grated coconut that is stored under frozen condition. Total microbial count of freeze dried grated coconut stored under room temperature was superior to fresh grated coconut that is stored under frozen conditions. Metalized polypropylene and polypropylene packs had similar effect towards tested quality parameters. Used storage conditions and packaging material did not have effect toward the organoleptic parameters of freeze dried grated coconut. Freeze dried grated coconut had a higher shelf life and superior quality parameters stored at room temperature compared to fresh grated coconut stored under frozen conditions.

KEYWORDS: Coconut, Freeze Dry, Quality Parameters & Storage

Received: Oct 21, 2019; **Accepted**: Nov 12, 2019; **Published**: Nov 28, 2019; **Paper Id**.: IJASRDEC201912

Original Article

1. INTRODUCTION

Coconut is very much demanded in the modern society due to its health effects and there is very high consumer demand in the developed countries for the low temperature processed coconut products as a supplement for the non-communicable diseases (Doty, 2012). Virgin coconut oil is one of the most demanded coconut products as it preserves the nutritional parameter under the low temperature processing conditions. Desiccated coconut is also a highly demanded product as a food ingredient, yet it is not demanded by health conscious communities due to its usage of elevated temperatures (~120^{o}C) during processing (Ginting *et. al*., 2015). Developments of low temperature processed commercial commodities provide opportunities to the product diversification of the coconut products and create higher demand, especially demanded among the health conscious communities. Presently, available low temperature processed grated coconut is in the frozen form and it has inherent limitations, as it requires cold chain maintenance for preservation, lower shelf life and limited usage due to higher moisture. Freeze drying has become commercially feasible technology to many food products including grated coconut due to its availability. This study aimed to identify the variation of quality parameters of freeze dried grated coconut packed in polypropylene and metalized polypropylene stored under different temperatures compared with the grated coconut preserved under frozen conditions.

2. METHODOLOGY

2.1 Sample Preparation

Well mature coconuts were selected for the study and they were de-husked, split and grated manually using a clean dry grater to an even size particles without getting the brown testa. Grated coconut was freeze dried using a freeze drying technology (Martin Christ, Alpha 1-2 LDplus) for 48 hours to get Freeze Dried Grated Coconut (FDGC). Fresh Grated Coconut (FGC) and Freeze Dried Grated Coconut (FDGC) were vacuum packed in metalized polypropylene (MP) and polypropylene (PP) bags of same weight for further experiments.

2.2 Sample Storage and Analysis

Samples were kept under room temperature (30^{o}C), refrigerated condition (5^{o}C), and frozen condition (-18^{o}C) for further analysis. Samples were drawn in consecutive time intervals for the moisture, free fatty acid, peroxide value, pH value, water activity, total microbial content and sensory evaluation.

Moisture content of the samples were measured using oven drying method, pH of the samples were measured using portable pH meter, free fatty acid was estimated as lauric acid by using titrametric method, peroxide value was measured by sodium thiosulphate titrametric method, water activity was measured using water activity meter (NOVASINA ms1), total microbial count was measured by total plate count method and sensory analysis was performed using nine point hedonic scale using semi-trained panellists. Samples were analyzed for the chemical parameter for every two weeks and microbial parameters of the samples were analyzed weekly. Sensory evaluations of the samples were done at the beginning of the study and at the end of the study (8 weeks). Data was statistically analysed using the Repeated Measurers ANOVA model using R Studio software.

3. RESULTS

Both the Freeze Dried Grated Coconut (FDGC) and Fresh Grated Coconut (FGC) were packed in Metalized Polypropylene (MP) and PolyPropylene (PP) packages and stored under room temperature (30^{o}C), refrigerated temperature (5^{o}C) and in frozen conditions (-18^{o}C). Fresh Grated Coconut (FGC) stored under room temperature and refrigerated conditions spoiled within two weeks, therefore, results of the study is limited to FGC stored under frozen conditions.

3.1 Chemical and Physical Parameter Variation

A gradual increase of moisture was observed in FDGC, having 2.24% moisture at the end of 8th week compared to initial value of 0.46%, having significantly high increments only between 0 to 2 weeks ($p=0.003$) and 2 to 4 weeks ($p=0.03$). A maximum of 0.77% of free fatty acid (as lauric acid) level was observed in FDGC at the 8th week of study compared to initial value of 0.48% having significant increases only during 4th week to 6th week ($p<0.001$) and 6th week to 8th week ($p<0.001$). A maximum of 4.46 mEq/kg of peroxide value was observed in FDGC at 8th week of study compared to initial value of 1.30 mEq/kg and it had also significant increments similar to free fatty acid values of FDGC. A maximum of 0.32 water activity value was observed in FDGC at 8th week compared to initial value of 0.06 and only significant increase of the value was observed from two to four weeks ($p = <0.001$) among the consecutive weeks. Acidity of FDGC slightly reduced to 6.58 pH value in FDGC compared to initial value of 6.26 pH.

At the end of eight weeks of study, FGC showed 48.1% moisture compared to initial value of 41.2% having significant moisture increments only from 0 to 2 week ($p<0.001$). A maximum of 2.07% of free fatty acid (as lauric acid)

was observed in FGC at 8th week compared to initial value of 0.55% having only significant FFA increment between 0 to 2 weeks. A maximum of 22.2 mEq/kg of peroxide value was observed in FGC compared to initial value of 6.07 mEq/kg and significant ($p<0.05$) increments of peroxide values were observed during each two week intervals of analysis. The water activity of FGC samples were at 0.88. The highest pH value was observed in 8th week (pH = 8.00) of FGC samples compared to initial value of 7.32 pH.

Metalized polypropylene (MP) had higher barrier properties to moisture compared to polypropylene (PP) in the FDGC stored under room temperature ($p = 0.008$) and refrigerated conditions ($p = 0.008$). There was no effect to moisture barrier properties of both packaging material (MP and PP) for the FDGC and FGC samples stored under frozen conditions ($p>0.05$).

Variation of free fatty acid (FFA) value, peroxide value, water activity and pH of the FDGC at different storage temperatures given in table 3.1.

Table 3.1: Effect of Storage Temperature for Physical/Chemical Parameters of FDGC

Temperature	FFA value	Peroxide Value	Water Activity	pH Value
Room (30°C)	0.74^{a}	2.81^{a}	0.29^{a}	6.19^{a}
Refrigerated (5°C)	0.65^{b}	2.38^{ab}	0.19^{b}	6.29^{a}
Frozen (-18°C)	0.55^{c}	1.89^{b}	0.16^{b}	6.52^{b}

Different superscript letters represent significant values ($p<0.05$)

3.2 Comparison of Chemical and Physical Parameters between FDGC Stored under Room Temperature and FGC Stored under Frozen Conditions

Significantly lower ($p<0.05$) moisture content, free fatty acid values, peroxide values, pH values and water activity values were observed in FDGC stored under room temperature (RT) compared to FGC stored under frozen condition.

3.3 Variation of Moisture Content

Initial moisture contents were adjusted to a common baseline value for the meaningful comparison of the moisture values. FDGC stored in different packaging material (MP and PP) did not have differences in moisture content ($P>0.05$) and FGC stored in different packaging material (MP and PP) did not have differences in moisture content ($P>0.05$). Moisture content increased significantly ($p<0.001$) in FGC stored in both packaging material (MP and PP) compared to FDGC stored in MP and PP packs. Variation of moisture content adjusted to a common baseline value of the FDGC stored under RT and FGC stored under frozen conditions are shown in figure 3.1.

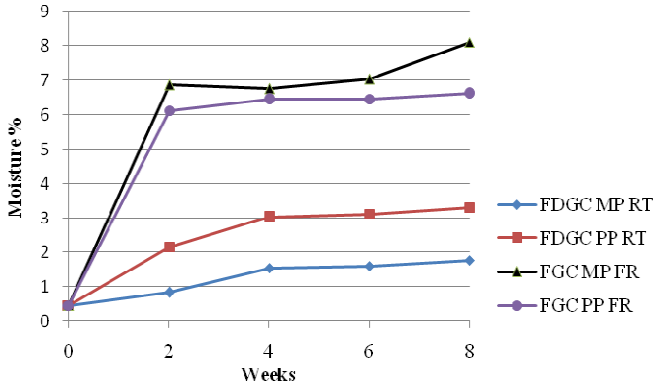

Figure 3.1: Variation of Baseline adjusted Moisture Content in FDGC and FGC Samples in different Packaging Material.

(FDGC MP RT-Freeze dried grated coconut metalized polypropylene room temperature; FDGC PP RT- Freeze dried grated coconut polypropylene room temperature; FGC PP FR- Fresh grated coconut polypropylene frozen storage; FGC MP FR- Fresh grated coconut metalized polypropylene frozen storage)

3.4 Variation of Water Activity Value

Water activity of FGC samples did not change over time, yet, FDGC samples increased water activity till 4th week of the study period. Packing material did not have effect on water activity for FGC samples and FDGC samples. Variation of water activity values of the FDGC stored under RT and FGC stored under frozen conditions are shown in figure 3.2.

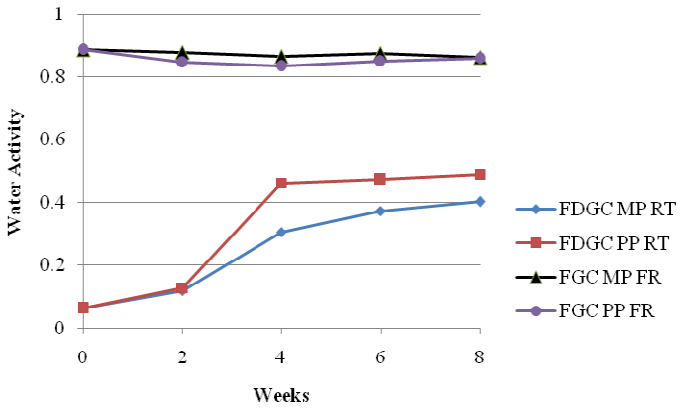

Figure 3.2: Variation of Water Activity of Coconut Stored under different Temperatures.

(FDGC MP RT-Freeze dried grated coconut metalized polypropylene room temperature; FDGC PP RT- Freeze dried grated coconut polypropylene room temperature; FGC PP FR- Fresh grated coconut polypropylene frozen storage; FGC MP FR- Fresh grated coconut metalized polypropylene frozen storage)

3.5 Variation of Free Fatty Acid (FFA) Value

Free Fatty Acid values increased over time during the study period. Significantly different ($p<0.05$) FFA values were observed in FGC stored in both packaging material (MP and PP). Compared to FGC, significantly lower ($p<0.05$) FFA values were observed in FDGC in both packages (MP and PP). No differences ($p>0.05$) were observed in FDGC samples over time. Variation of FFA values of the FDGC stored under RT and FGC stored under frozen conditions are shown in figure 3.3.

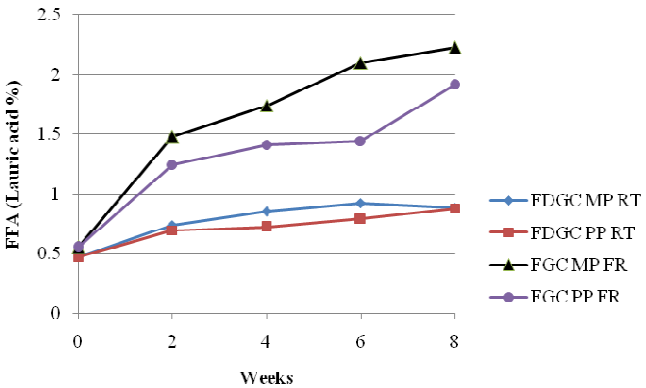

Figure 3.3: Variation of Free Fatty Acid Value of Coconut Stored under Different Temperatures.

(FDGC MP RT-Freeze dried grated coconut metalized polypropylene room temperature; FDGC PP RT- Freeze dried grated coconut polypropylene room temperature; FGC PP FR- Fresh grated coconut polypropylene frozen storage; FGC MP FR- Fresh grated coconut metalized polypropylene frozen storage)

3.6 Variation of Peroxide Value

Peroxide values increased over time during study period. Significantly higher ($p<0.05$) peroxide values were observed in FGC samples compared to FDGC samples. Packaging material did not have effect towards peroxide value for both FGC and FDGC samples. Variation of peroxide values of the FDGC stored under RT and FGC stored under frozen conditions are shown in figure 3.4

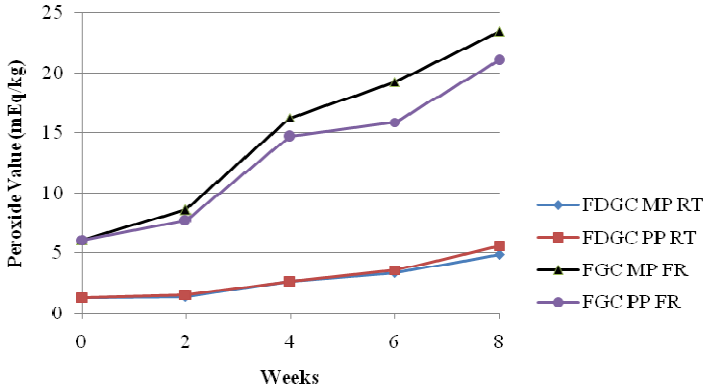

Figure 3.4: Variation of Peroxide Value of Coconut Stored under Different Temperatures.

(FDGC MP RT-Freeze dried grated coconut metalized polypropylene room temperature; FDGC PP RT- Freeze dried grated coconut polypropylene room temperature; FGC PP FR- Fresh grated coconut polypropylene frozen storage; FGC MP FR- Fresh grated coconut metalized polypropylene frozen storage)

3.7 Variation of pH Value

Lower pH values were observed in FDGC samples compared to FGC samples ($p<0.05$). Variation of pH values of the FDGC stored under RT and FGC stored under frozen conditions are shown in figure 3.5.

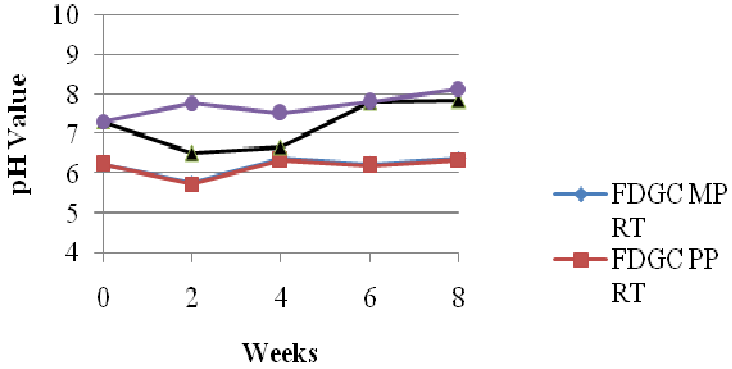

Figure 3.5: Variation of Ph Value of Coconut Stored under Different Temperatures.

(FDGC MP RT-Freeze dried grated coconut metalized polypropylene room temperature; FDGC PP RT- Freeze dried grated coconut polypropylene room temperature; FGC PP FR- Fresh grated coconut polypropylene frozen storage; FGC MP FR- Fresh grated coconut metalized polypropylene frozen storage)

3.8 Microbial Parameter Variation

Increment of total microbial count was observed in all the samples over time. Type of packaging did not have significant effect ($p>0.05$) on microbial content. Significantly different microbial counts were observed in FDGC samples stored under different storage conditions while having lowest microbial counts in frozen storage and highest microbial counts in room temperature storage. At the end of eight weeks storage, FDGC stored under frozen, refrigerated and room temperature storage reached log 6, log 7 and log 8 counts respectively.

FDGC under storage of room temperature had similar number of total plate count with FGC under frozen storage ($p>0.05$). Figure 3.6 shows the variation of total plate count of FDGC under room temperature and FGC under frozen temperature.

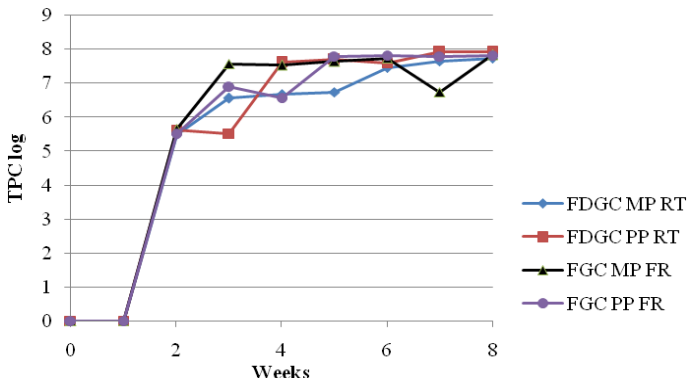

Figure 3.6: Variation of TPC of FDGC at Room Temperature and FGC at Frozen Storage.

(FDGC MP RT-Freeze dried grated coconut metalized polypropylene room temperature; FDGC PP RT- Freeze dried grated coconut polypropylene room temperature; FGC PP FR- Fresh grated coconut polypropylene frozen storage; FGC MP FR- Fresh grated coconut metalized polypropylene frozen storage)

3.9 Sensory Parameter Variation

Consumers preferred fresh coconut compared to freeze dried coconut. No significant differences ($p>0.05$) were observed between freeze dried grated coconut stored under various storage temperatures (Room temperature, Refrigerated, Frozen).

4. DISCUSSIONS

Fresh coconut samples stored under room temperature and refrigerated conditions spoiled within two weeks showing the effect of temperature toward microbial, enzymatic and chemical activity. It is essential to maintain frozen conditions in preserving the fresh grated coconut using low temperature. Freeze drying technology removes most of the free water leading to lower water activity (Damodaran *et. al.*, 2008). Environment lacks in free water hinders the microbial, enzymatic and chemical reactions that results food spoilage, therefore freeze dried food can be preserved for longer period without spoilage. Freeze dried grated coconut had moisture contents lower than 0.6 water activity, therefore organism which can grow under the most dried conditions (osmophilic yeast) even unable to grow under the present conditions (Jay, 2000). Over the time, even the freeze dried grated coconut samples showed microbial growth most probably due to the moisture migration through the polypropylene and metalized polypropylene packaging material and generation of moisture due to enzymatic and chemical reactions in micro-environments of package (Hong and Krochta, 2003). Both metalized

polypropylene and polypropylene had similar barrier properties, therefore selection of the packaging material type shall be done considering the economic, aesthetic factors and consumer preferences.

Fatty foods develop offensive odours and flavours during the hydrolysis. Higher free fatty acid levels create offensive odours and flavours in most of the food, therefore food producers prefer to keep the FFA value below 1% (Dayrit *et. al*., 2007). Freeze dried grated coconut did not exceed the 1% level even at 8 weeks of storage at room temperature; yet fresh grated coconut exceeded the above value within two weeks of frozen storage.

Low peroxide value signifies its high oxidative stability and generally peroxide value over 30 meq/kg results noticeable rancidity (Marina *et. al*., 2009). Freeze dried grated coconut stored at room temperature had four times lower peroxide value compared to fresh grated coconut stored under frozen conditions showing the stability of FDGC toward rancidity development.

Fresh grated coconut stored under frozen conditions had similar microbial counts compared to freeze dried grated coconut stored under room temperature. Maintenance of frozen chain in marketing is a large expenditure in food business, therefore freeze dried grated coconut has added advantages over fresh grated coconut. Polypropylene has permeable properties to gas and moisture, which may have resulted some microbial growth and increment of chemical parameters such as peroxide value and free fatty acids over time. Utilization of laminated package having higher moisture and gas barrier properties can further extend the shelf life of freeze dried grated coconut without using preservatives.

5. CONCLUSIONS

The results indicate that freeze dried grated coconut stored at room temperature is superior in chemical and microbial characters compared to fresh grated coconut stored under frozen conditions. Requirement of the frozen chain and lower shelf life are major limitations of fresh grated coconut, therefore there is high market potential for the freeze dried grated coconut as a low temperature processed value added novel coconut product.

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AUTHOR PROFILE

Dhanesh Nadeejaya Liyanage, completed his Bachelors of Science in Agriculture Degree from the Wayamba University of Sri Lanka specializing in Food Science and Technology winning two medals at the general convocation of the same university. He obtained a MS in Food Safety and Technology from the Illinois Institute of Technology, USA. He has completed a certificate course in Teaching in Higher Education from the Colombo University of Sri Lanka. He also took oaths as an Attorney-at-Law from the Supreme Court of Sri Lanka. He is currently working as a Senior Lecturer attached to the Department of Food Science and Technology of Wayamba University of Sri Lanka. He is interested in research commercialization and he was the coordinator of the World Bank funded project, "Commercialization of research and, provision of technical services to the industry via the development of a corporate research model" at Wayamba University of Sri Lanka. Further he obtained grants from Wayamba University of Sri Lanka, German International Cooperation (GIZ) and USAID. He has involved in many researches and two of his research findings were Internationally Patented. He involved in research in the areas of Food Science researches and Higher Education researches and he has about ten journal publications and over twenty communications in research conferences. He is also having memberships in Sri Lanka Bar Association and Sri Lanka Association for the Advancement of Science.